UNIFORM EMBEDDING FOR EFFICIENT STEGANOGRAPHY OF H.264 VIDEO

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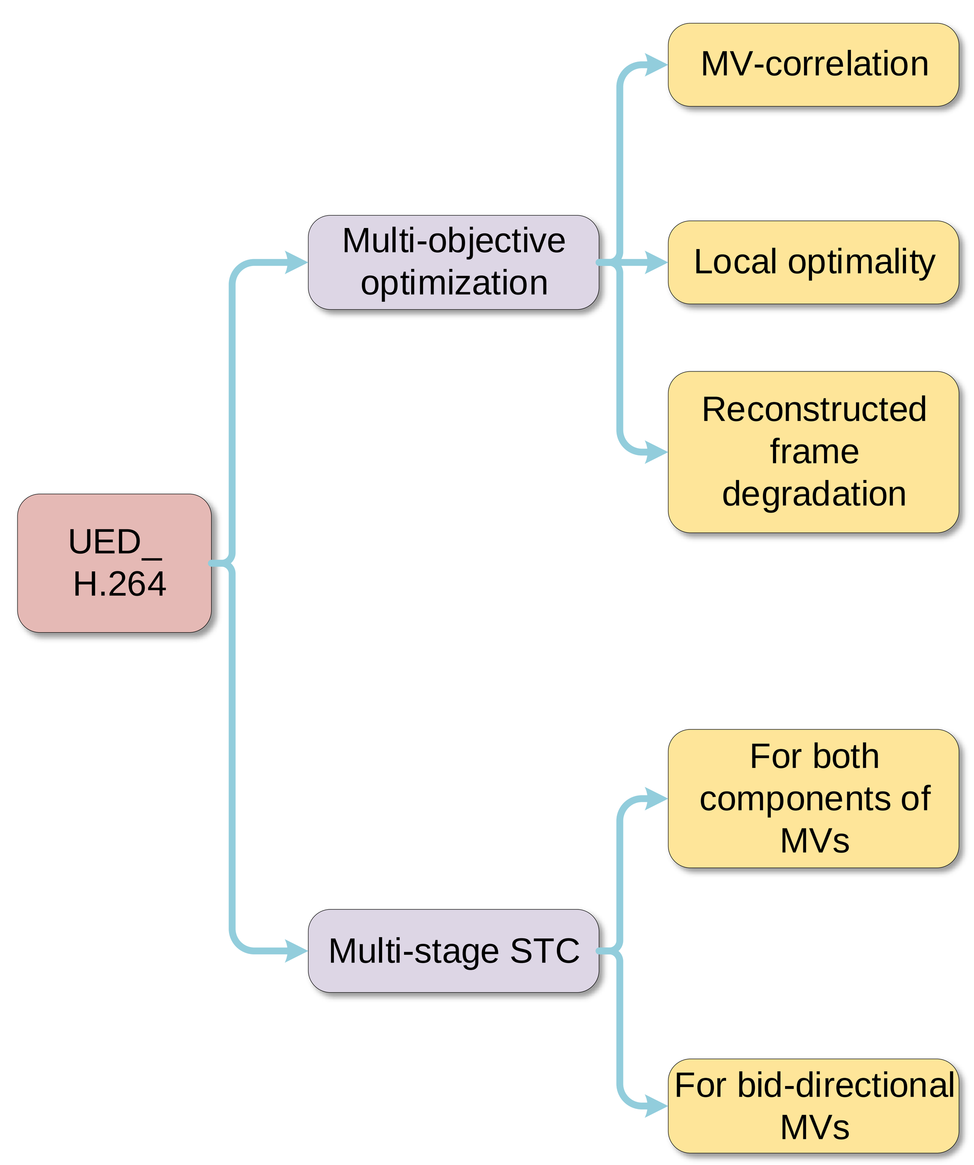
Introduction

In our paper, a video steganography scheme – **UED_H.264** is proposed by taking into account the several key issues in video steganography, e.g., the MV correlations, the local optimality and the degradation of the reconstructed video frames. Data are embedded in MVs with multi-stage STC appropriately.



The framework for UED_H.264

The multi-objective optimization

- **Uniform Embedding to Maintain the MV Distributions**

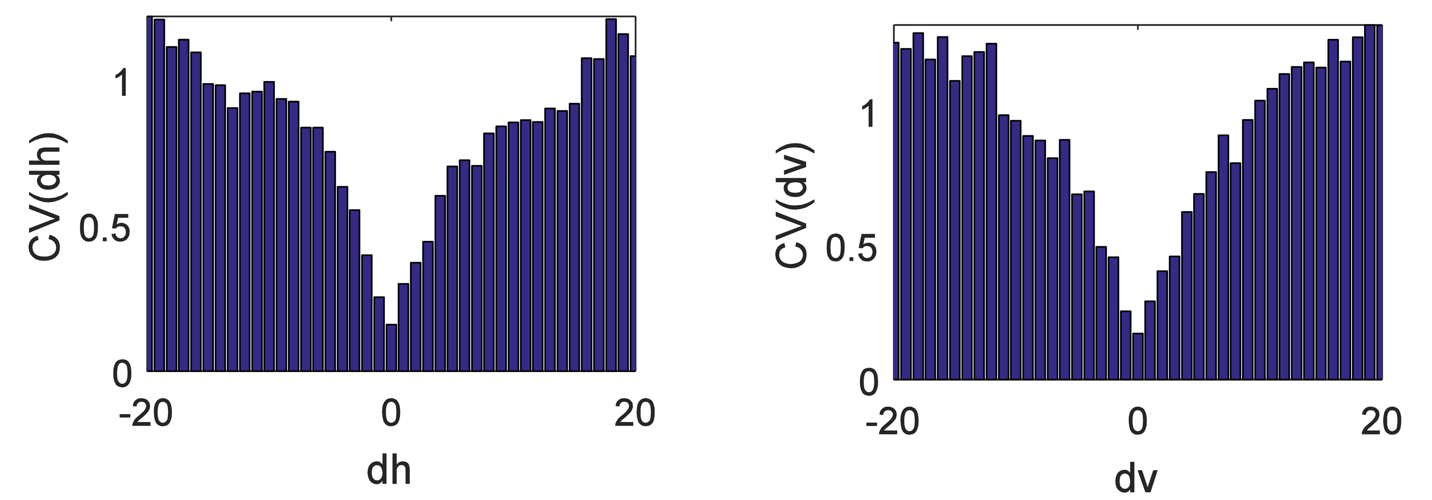
The motion vector difference (MVD) is reasonable to evaluate the correlation of the MVs. As MVD has similar distribution with JPEG, UED is adopted to minimize the impact on the MV correlation.

The correlation factor for *h*:

$$f_n^c(\Delta h)=\begin{cases}0 & \Delta h=0\\ \lambda(QP)|dh_n|^{-1} & \Delta h=\pm1, dh_n\neq0\\ 10\cdot\lambda(QP) & \Delta h=\pm1, dh_n=0\end{cases}$$

The correlation factor for *v*:

$$f_n^c(\Delta v)=\begin{cases}0 & \Delta v=0\\ \lambda(QP)|dv_n|^{-1} & \Delta v=\pm1, dv_n\neq0\\ 10\cdot\lambda(QP) & \Delta v=\pm1, dv_n=0\end{cases}$$



- **The Effect on Local Optimality**

As the sum of absolute difference (SAD) and the sum of absolute transform difference (SATD) are no less than 0, if the residual block of the modified MV is quantized to zero, the local optimality will be hold.

The local optimal factor for *h*:

$$f_n^q(\Delta h)=\begin{cases}\frac{1}{3}\sum_{\Delta v\in\{\pm1,0\}}\lfloor c_n(\Delta h,\Delta v)\rfloor & \exists\Delta v, D(V_n^{\Delta h,\Delta v})\leq T_s^4\\ \inf & otherwise\end{cases}$$

The local optimal factor for *v*:

$$f_n^q(\Delta v|\Delta h_n)=\begin{cases}\left\lfloor\frac{D(V_n^{\Delta h_n,\Delta v})}{16}\right\rfloor & D(V_n^{\Delta h_n,\Delta v})\leq T_s^4\\ \inf & otherwise\end{cases}$$

- **The Degradation of the Reconstructed Frames**

To minimize the degradation of the reconstructed frames, a distortion factor is proposed to evaluate the similarity between the residual blocks.

The local optimal factor for *h*:

$$f_n^d(\Delta h)=\frac{1}{3}\sum_{\Delta v\in\{\pm1,0\}}\lfloor d_n(\Delta h,\Delta v)\rfloor$$

The local optimal factor for *v*:

$$f_n^d(\Delta v|\Delta h_n)=\lfloor d_n(\Delta h_n,\Delta v)\rfloor$$

- **The Overall Distortion Function**

By combining all these factors together, we have the overall distortion function for horizontal component Δh and vertical component Δv respectively.

The overall distortion function for *h*:

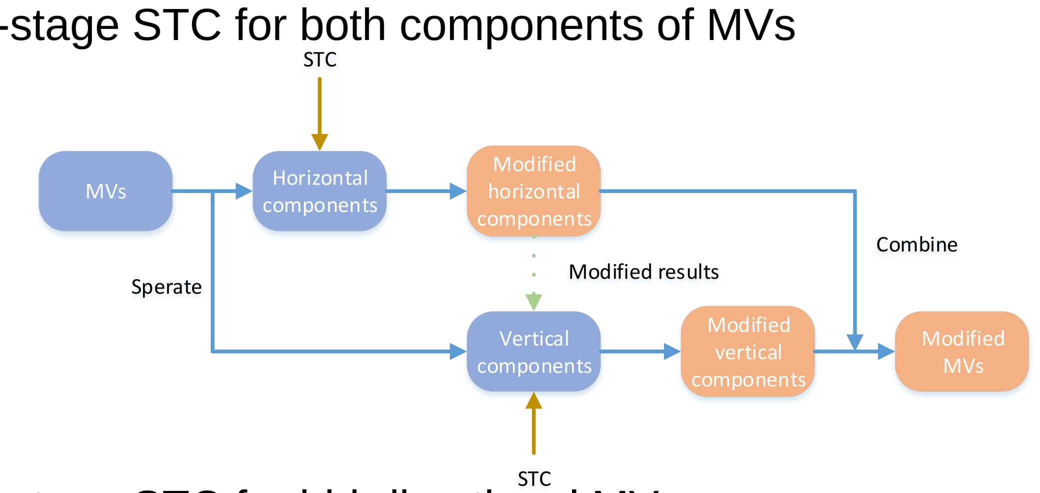
$$f_n^f(\Delta h)=f_n^t(\Delta h)\cdot\left(f_n^q(\Delta h)+1\right)^{\alpha}\cdot\left(f_n^d(\Delta h)+1\right)^{\beta}\cdot f_n^c(\Delta h)$$

The overall distortion function for *v*:

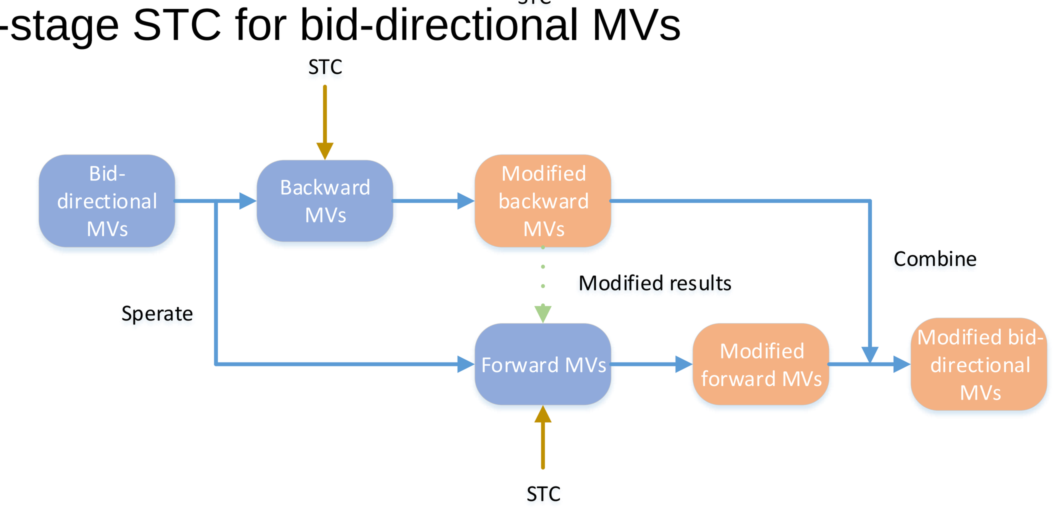
$$f_n^f(\Delta v|\Delta h_n)=f_n^t(\Delta v)\cdot\left(f_n^q(\Delta v|\Delta h_n)+1\right)^{\alpha}\cdot\left(f_n^d(\Delta v|\Delta h_n)+1\right)^{\beta}\cdot f_n^c(\Delta v|\Delta h_n)$$

The multi-stage STC embedding

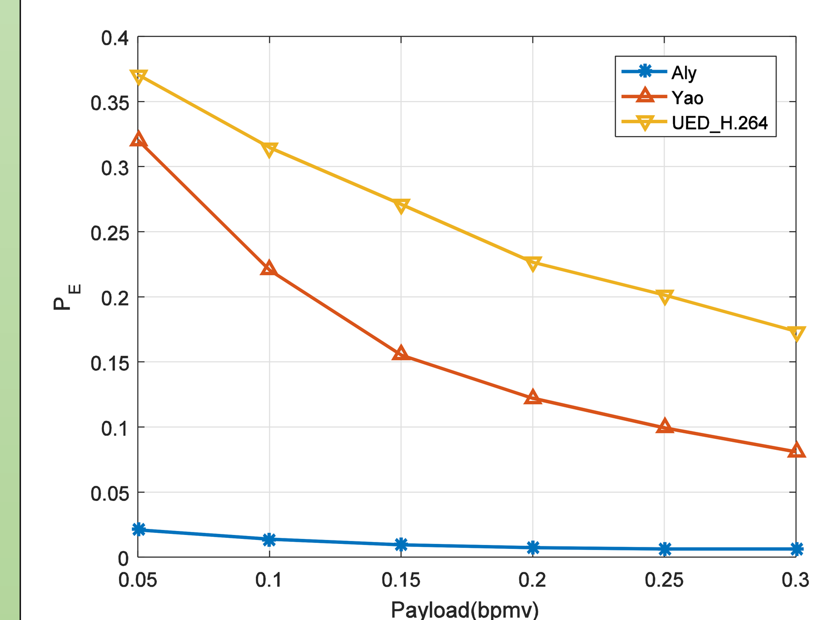
The multi-stage STC for both components of MVs



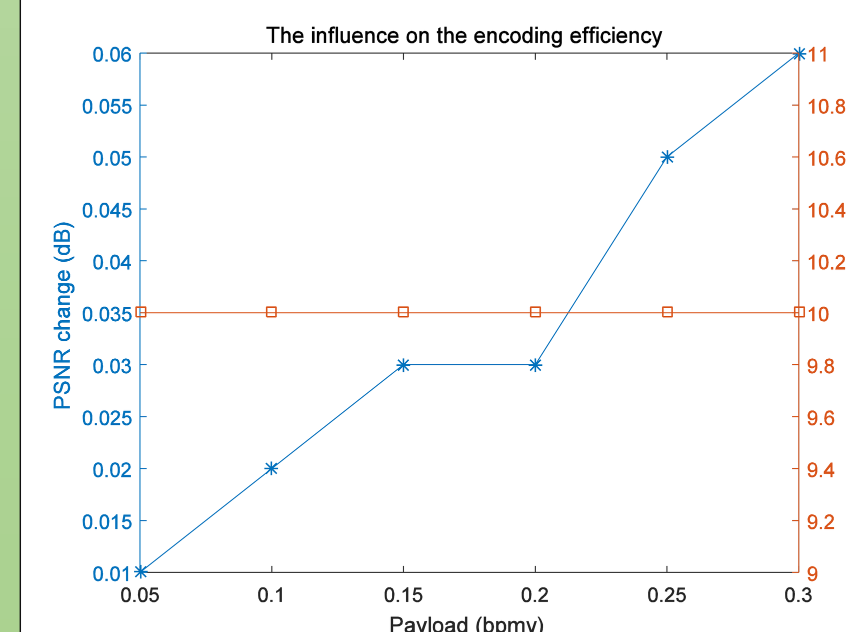
The multi-stage STC for bid-directional MVs



Experiment result and analysis



The detection error for Aly's scheme, Yao's scheme and the proposed scheme with NPEFLO under different payloads.



The influence on the compressed video quality and encoding speed caused by UED_H.264.